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PATENT APPLICATION

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Applicants: **Simon P. VALENTINE, Christopher R. LINZELL,
Lee A. WALKER**

Case: **3Com-81(3022US)**

Serial No.:

Filed:

Group Art Unit:

Examiner:

Title: **EFFICIENT METHOD OF DEDUCING NETWORK TOPOLOGY
INCLUDING ENDSTATIONS**

Commissioner for Patents
BOX PATENT APPLICATION
Washington, D. C. 20231

S I R:

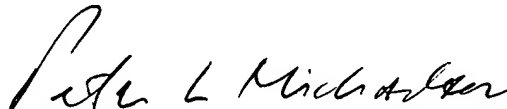
SUBMISSION OF PRIORITY DOCUMENT

In connection with the above-captioned
application, applicants enclose the following priority
document to support their claim to priority:

UNITED KINGDOM - Appl. No. 0009045.6, filed
April 12, 2000.

Respectfully submitted,

September 14, 2000


Peter L. Michaelson, Attorney
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INVESTOR IN PEOPLE

The Patent Office
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I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Controller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

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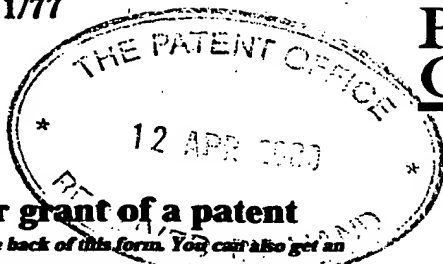
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W. Evans

Dated 8 May 2000

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The Patent Office

1/77

17APR00 E529333-8 D00016
P01/7700 0.00-0009045.6

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1. Your reference

HRW/sb/3Com3022GB

2. Patent application number

(The Patent Office will fill in this part)

12 APR 2000

0009045.6

3. Full name, address and postcode of the or of each applicant (underline all surnames)

3Com Corporation
5400 Bayfront Plaza M/S 1308
Santa Clara
California CA95052 USA

Patents ADP number (if you know it)

If the applicant is a corporate body, give the country/state of its incorporation

Delaware, USA

765 6978001

4. Title of the invention

Efficient Method of Deducing Network Topology including Endstations

5. Name of your agent (if you have one)

BROOKES & MARTIN

"Address for service" in the United Kingdom to which all correspondence should be sent (Including the postcode)

HIGH HOLBORN HOUSE
52-54 HIGH HOLBORN
LONDON
WC1V 6SE

Patents ADP number (if you know it)

471001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number

Country

Priority application number
(if you know it)

Date of filing
(day / month / year)

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application

Date of filing
(day / month / year)

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if:

Yes

a) any applicant named in part 3 is not an inventor, or

b) there is an inventor who is not named as an applicant, or

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See note (d))

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Request for preliminary examination and search (Patents Form 9/77) 1

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Any other documents -
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11. I/We request the grant of a patent on the basis of this application.

Signature

Date

11 April 2000

12. Name and daytime telephone number of person to contact in the United Kingdom

Hugh R Wright

01892 510600

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Notes

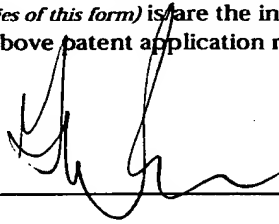
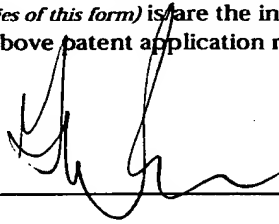
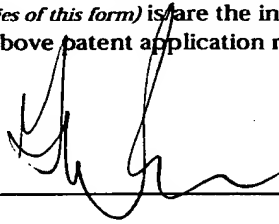
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**Statement of inventorship and of
right to grant of a patent**

The Patent Office

Cardiff Road
Newport
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NP9 1RH

1. Your reference	HRW/sb/3Com3022GB					
2. Patent application number <i>(if you know it)</i>	112 APR 2000	0009045.6				
3. Full name of the or of each applicant	3Com Corporation					
4. Title of the invention	Efficient Method of Deducing Network Topology including Endstations					
5. State how the applicant(s) derived the right from the inventor(s) to be granted a patent	By virtue of the employment of the inventors and their employment contracts					
6. How many, if any, additional Patents Forms 7/77 are attached to this form? <i>(see note (c))</i>						
7.	<p>I/We believe that the person(s) named over the page <i>(and on any extra copies of this form)</i> is/are the inventor(s) of the invention which the above patent application relates to.</p> <table border="0" style="width: 100%;"> <tr> <td style="width: 50%;">Signature</td> <td style="width: 50%;">Date</td> </tr> <tr> <td style="text-align: center;"></td> <td style="text-align: center;">11 April 2000</td> </tr> </table>		Signature	Date		11 April 2000
Signature	Date					
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8. Name and daytime telephone number of person to contact in the United Kingdom	Hugh R Wright	01892 510600				

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Enter the full names, addresses and postcodes of the inventors in the boxes and underline the surnames

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Reminder

Have you signed the form?

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EFFICIENT METHOD OF DEDUCING NETWORK TOPOLOGY INCLUDING ENDSTATIONS

BACKGROUND OF THE INVENTION

5

The present invention relates to a method and apparatus for deducing network topology.

10

The present invention relates to the process of discovery of the devices on a network, that is a network of electronic devices comprising, for example, workstations, personal computers, servers, hubs, routers, bridges, switches, (hereinafter referred to as devices of the network), and links between these devices which may be in the form of physical cable or wireless links. The network may be a local area network (LAN), such as an Ethernet network, wide area network (WAN) or other types, including

15

wireless networks.

Computers and other devices connected to a network may be managed or unmanaged devices. A managed device has processing capability, which enables it to monitor data traffic sent from, received at, and passing through the ports of the device.

20

Monitored data associated with the ports of the network device is stored in memory on the network device. For example, data relating to the origin of a data packet which is received at a port is stored along with the identity of the relevant port.

25

After such a network has been installed, it is desirable for the person appointed network manager to be able to understand the technical operation of the network.

In known network management systems, the manner in which the relevant data is retrieved from the managed devices, compiled and displayed ("discovered") has been problematic in several respects.

30

The topology of the network may be deduced by the network manager's computer by the process of discovery in which each of the devices of the network is interrogated to thereby produce on a network manager's workstation details of the network and its

operation, preferably in the form of a network map which may be displayed on a visual display unit showing the devices and links between the devices. At its simplest, and where the device is a "managed" device, this information is usually provided by interrogation using a known protocol, such as the SNMP (Simple Network Management Protocol), of the so-called 'agent' of each device which stores the device's unique MAC address, the type of device and the MAC addresses embedded in the data passing into a particular port which thereby gives the MAC addresses of the origin of the data and hence the MAC address of the devices which are connected to the ports directly or indirectly.

One particular problem is that in any but the simplest of networks, the discovery procedure can be very slow in view of the large number of interrogations required.

It would be desirable to reduce the number of interrogations required to speed up the discovery process.

SUMMARY OF THE INVENTION

The present invention provides a method for discovering the topology of a network comprising:

initially resolving the positions of the end stations, and subsequently resolving the topology of the remaining devices.

The present invention also provides a computer program on a computer readable medium loadable into a digital computer or embodied in a carrier wave, said program including software for carrying out the method of the preceding paragraph.

The present invention also provides a computer program on a computer readable medium loadable into a digital computer or embodied in a carrier wave, for discovering the topology of a network comprising:

a program step to query a port of a managed device for a first address of any packet which has been received;

a program step for querying the same port of the device for a second address of any packet which has been received;

if there is no second address, returning relevant data to a manager and determining if there is another port on the device;

5 if there is a second address, determining if there is another port on the device;

if there is another port on the device, repeating the preceding four steps for another port of the managed device;

if not, repeating the preceding five steps in respect of another managed device.

10 **BRIEF DESCRIPTION OF THE DRAWINGS**

A preferred embodiment of the invention will now be described by way of example only and with reference to the accompanying drawings in which:-

15 Figure 1 shows a network to be discovered,

Figure 2 is a table of learnt addresses for each port, and

Figure 3 is a flow chart of a program for carrying out the preferred method of the invention.

20 **DESCRIPTION OF THE PREFERRED EMBODIMENTS**

The physical network to be discovered may comprise a plurality of devices in the form of a network supervisor's workstation or computer, other workstations, hubs, or switches.

25

The devices are connected together by means of links which may be hard wired or wireless and utilise any desired protocol.

30

The network supervisor's workstation includes, in addition to a visual display unit, a central processing unit or signal processor, a selector which may be in the form of a mouse, a program store which may comprise, for example, a CD drive, a floppy disk

drive or a zip drive, and a memory for storing a program which may have been loaded from the program store or downloaded for example via Internet from a website.

To discover the network, using SNMP, the network supervisor's computer
 5 interrogates each device and analyses the network, and stores in the memory the information relating to the devices within the network and the links between the devices. In essence, managed devices include a so-called agent which in the case of an SNMP agent stores information about the device such as its unique MAC address, its sysObject ID (which identifies what the device is and its model type), how many
 10 ports it has, and the MAC address of the origin of the data which at least some of the ports have received and hence to which they are directly or indirectly connected. The computer interrogates the agents of each device.

In a preferred arrangement, the computer may, on command from the selector,
 15 process signals from the memory by the signal processor and provide on the visual display unit a network map showing each of the devices and the links therebetween. In the examples described, the network is simple but of course in many instances the network will be considerably more complex and it may be necessary to arrange that the visual display unit only shows a simplified version or only part of the network at
 20 any one time.

Figure 1 shows an example of a simple network topology. The managed devices which may be switches and hubs are represented by the rectangles labelled A – D. Each device has three or four ports labelled, for example, A1, A2, A3, B1, B2, B3, B4. End stations, that is devices which have only a single connection to the network
 25 and are typically Personal Computers or workstations, are represented by squares R – Z. As is well known the ports of a managed device will learn the source MAC addresses of any packets of data that pass through them from another device. Referring to Figure 2, there is set out a table listing each of the ports of Figure 1, and
 30 the addresses learnt by each port and which is stored on the relevant agent. Thus port A1 will learn all of the addresses of device B and the devices to which it is attached and will thus learn the MAC address of B, X, Y, Z. Note that to simplify the

explanation, the table assumes that any packet transmitted by a device is seen by all nodes downstream of it. In a switched network this may not necessarily be the case.

5 In order to determine the topology of the network, as already explained, the network manager's computer queries each managed node to determine the addresses of other nodes on the network to which it has been connected. This would include the address of all other managed nodes and the end stations. This type of request normally involves interrogating all of the end stations (one request per address) or interrogating each address (again potentially one request per address). This data can then be used
10 to determine the relative locations of all of the nodes on the network.

In order to reduce the number of interrogations or requests, we arrange for the position of the end stations to be resolved before attempting to deduce the relative positions of the managed devices. This can be done by querying each managed
15 device to return details of any ports that have only learnt one address and to return that address. Thus in the example of Figure 1, such ports would be B1, B3, B4, C2, C3, C4, D2, D3, and D4 (ie those ports are connected to end stations). In order to obtain this information, two requests per port are made, one to obtain the first address, and another to determine if there is a second address. In the example given, this
20 means that for each of B, C and D, eight requests (two times the number of ports) are made per device in order to determine the attached end stations. This request procedure replaces in the prior art the one request per end station (a total of nine).

In a real network there is likely to be significantly more end stations than managed
25 devices and ports on a device. For example, in a network of twenty managed devices and four hundred end stations, where each device has approximately 20 ports in use, to resolve the end stations for each managed device would require about forty requests rather than a total of four hundred requests to cover all of the end stations using the prior procedure.

30 Having resolved the end stations, the discovery of the remaining managed devices can proceed. Thus it is only necessary to discover the relative positions of the managed

devices. To do this only requires a small number of requests per device. For example, for device A, the query "which ports have learnt the addresses of device B, C or D?" would be made which would require only three requests (ie the topology of the end station is already known).

5

The preferred method of the invention is carried out under the control of the network manager's workstation or computer and in particular by means of a program controlling the processor apparatus of that computer or elsewhere in the system.

10

The program for controlling the operation of the invention may be provided on a computer readable medium, such as a CD, or a floppy disk, or a zip drive disk carrying the program or their equivalent, or may be provided on a computer or computer memory carrying the website of, for example, the supplier of the network products. The program may be downloaded from whichever appropriate source and

15

used to control the processor to carry out the steps of the invention as described.

The program may include an algorithm of the form set out in the flow chart (Figure 2) of the drawings.

20

Thus the program may include the following steps:

program step 101, network manager's computer polls a managed device;

program step 102, query a port of the device for a first MAC address of any packet which has been received;

25

program step 103, query the same port of the device for a second MAC address of any packet which has been received;

if there is not a second MAC address, (ie the first MAC address is an end station) in program step 104, return relevant data to manager and go to step 105;

if there is a second MAC address, go to step 105;

30

in step 105, is there another port on the device?;

if yes, go to program step 102;

if no, go to program step 106;

in program step 106, is there another device?

if there is another device, go to program step 101;

if there is not another device, go to step 107;

in program step 107, resolve the managed devices.

5

The invention is not restricted to the details of the foregoing example.

CLAIMS

1. A method for discovering the topology of a network comprising:
initially resolving the positions of the end stations, and subsequently resolving
5 the topology of the remaining devices.
2. A method as claimed in claim 1 in which the step of initially resolving the
positions of the end stations comprises, for each managed device, determining which
ports are only connected to an end station.
10
3. A method as claimed in claim 1 or claim 2 in which the step of resolving the
topology of the remaining devices comprises:
querying for each managed device, which ports have learnt the address of
another managed device.
15
4. A computer program on a computer readable medium loadable into a digital
computer or embodied in a carrier wave, said program including software for carrying
out the method of any of claims 1 to 3.
- 20 5. A computer program on a computer readable medium loadable into a digital
computer or embodied in a carrier wave, for discovering the topology of a network
comprising:
a program step to query a port of a managed device for a first address of any
packet which has been received;
25 a program step for querying the same port of the device for a second address
of any packet which has been received;
if there is no second address, returning relevant data to a manager and
determining if there is another port on the device;
if there is a second address, determining if there is another port on the device;
30 if there is another port on the device, repeating the preceding four steps for
another port of the managed device;
if not, repeating the preceding five steps in respect of another managed device.

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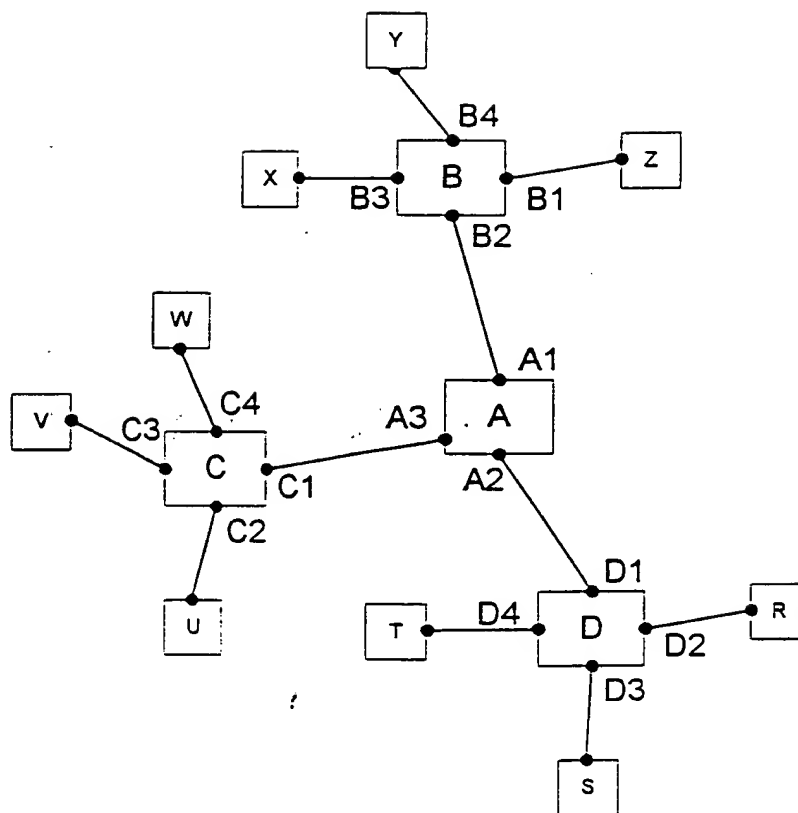


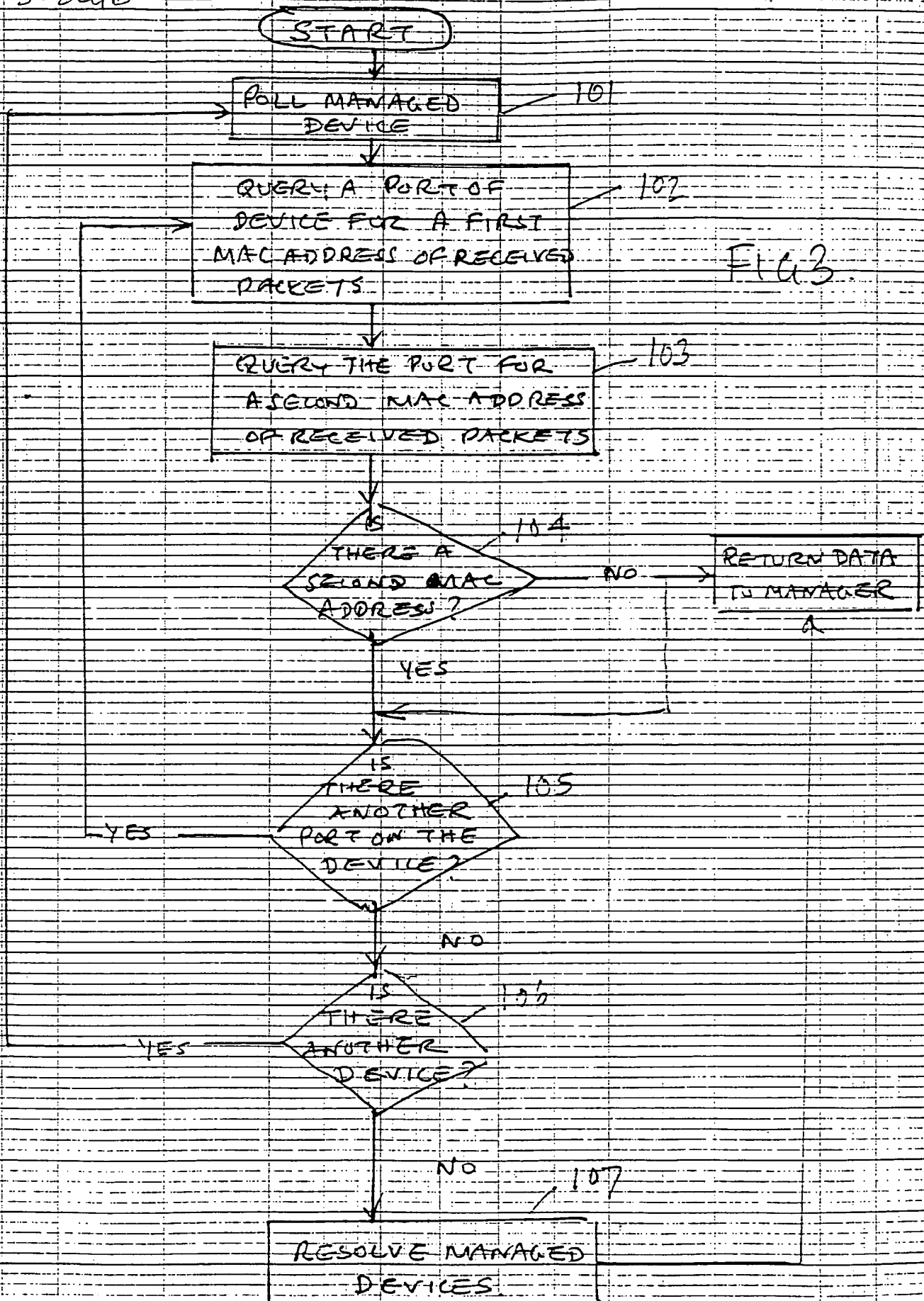
Fig. 1 ~~Topology Example~~

Port	Learnt addresses
A1	B, X, Y, Z
A2	D, R, S, T
A3	C, U, V, W
B1	Z
B2	A, C, D, R, S, T, U, V, W
B3	Y
B4	Z
C1	A, B, D, R, S, T, X, Y, Z
C2	U
C3	V
C4	W
D1	A, B, C, U, V, W, X, Y, Z
D2	R
D3	S
D4	T

Fig. 2 ~~Learnt Addresses~~

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